STATEMENT OF WORK
DEC 2004

NAVSEA NO. 802-7379413

1,200 GALLON PER DAY REVERSE OSMOSIS (RO) DESALINATION UNIT

1.0 SCOPE

This Reverse Osmosis (RO) Desalination Unit is designed for the purpose of producing 1,200 gallons per day (GPD) of freshwater with a total dissolved solids level below 25 parts per million. This statement of work document provides the requirements for the RO desalination unit.

1.1 Technical Data Package

The Contractor shall use this statement of work document to produce the required First Article and all other production units.

1.2 First Article Testing

The first RO Unit ship set shall be fabricated for use in First Article Testing (see para. 4.3). The first RO unit ship set consists of two independent 1,200 GPD RO units.

1.3 Production

The Contractor shall begin design and fabrication of the First Article Unit ship set, from contract award. Once First Article Testing has been completed, and test reports accepted and approved by the Contracting Agency, the Contractor shall begin fabrication of the production units.

1.4 Critical Manufacturing Points (CMP)

Naval Surface Warfare Center (NSWC) or a NSWC designated agent will review and inspect ongoing manufacturing efforts at the critical points listed below during manufacture of the First Article as well as at any time during manufacture of the RO units.

Critical Manufacturing Points (CMP) are defined as:

a. at a point during the initial development of the process and instrumentation and flow diagrams of the RO unit
b. at a point where the process and instrumentation and flow diagrams are in final development and the initial list of components and materials of construction has been developed
c. at a point where the detailed drawing development for the RO unit is approx. 50 percent complete, the process and instrumentation and flow diagrams are finalized, and the majority of the components have been selected
d. at a point where the detailed drawing development for the RO unit is 100 percent complete, all the components have been selected, and prior to actual start of fabrication
e. after unit fabrication is 75 percent complete
f. after final assembly
g. at the start of each of the first article tests
h. at the final unit inspection following completion of all first article testing.

The Contractor shall notify NSWC one week prior to reaching the above CMPs.

2.0 APPLICABLE DOCUMENTS

2.1 General

The following documents shall form a part of this statement of work document to the extent specified herein.

2.2 Government Documents

2.2.1 Specifications, Standards, and Handbooks

The following specifications, standards, and handbooks form a part of this specification to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-F-1183J dated 5 May 1987 - Fittings, Pipe, Cast Bronze, Silver Brazing, General Specification For

MIL-S-1222G with Amendment 3 dated 29 December 1980 - Studs, Bolts, Screws, Socket Head Cap Screws and Nuts

MIL-E-2036D dated 10 March 1988 - Enclosures for Electric and Electronic Equipment, Naval Shipboard

MIL-DTL-2212H dated 10 February 1997 - Contactors and Controllers, Electric Motor AC or DC, and Associated Switching Devices

MIL-PRF-2490D dated 13 April 1999 - Snubbers, Fluid Pressure, Instrument Protection

MIL-T-16420K with Amendment 1 dated 16 September 1988 - Tube, Copper Nickel Alloy, Seamless and Welded

MIL-I-17244E with Notice 1 dated 7 June 1991 – Indicators, Temperature, Direct Reading, Bimetallic, (3 and 5 Inch Dial)

MIL-PRF-20042E dated 16 September 1999 - Flanges, Pipe, Bronze, (Silver Brazing)

MIL-T-24270B dated 2 September 1983 - Thermowells for Thermometers and Electrical Temperature Sensors, General Specification for

MIL-T-24388C dated 30 March 1990 – Thermocouple and Resistance Assemblies, General Specification for (Naval Shipboard)

MIL-V-24578B dated 27 May 1988 - Valves, Globe, Pressure Instrument, Stem Test Connection, Union End

MIL-C-24643A dated 13 Mar 1996 – Cables and Cords, Electric, Low Smoke, for Shipboard Use, General Specification for

MIL-D-24709 dated 4 November 1988 - Distributed Isolation Material Type R-50-21/64, 4 November 1988

MIL-I-45208A dated 20 September 1995 - Inspection System Requirements, 20 September 1995

STANDARDS

MIL-STD-22D with Notices 1 and 2 dated 31 January 1984 - Weld Joint Design

MIL-STD-167/1 dated 19 June 1987 - Mechanical Vibrations of Shipboard Equipment (Type I, Environmental and Type II Internally Excited)

MIL-STD-167/2 dated 26 November 1991 - Mechanical Vibrations of Shipboard Equipment (Type III, Reciprocating Machinery)

MIL-STD-461E dated 20 August 1999 - Electromagnetic Emission and Acceptability Requirements

MIL-STD 470A with Notice 1 dated 26 August 1987 - Maintainability Program for Systems and Equipment

MIL-STD-781D dated 17 October 1986 - Reliability Testing for Engineering Development, Qualification, and Production

MIL-STD-785B dated 3 July 1986 - Reliability Program for Systems and Equipment Development and Production

MIL-STD-1310G dated 28 June 1996 - Shipboard Bonding, Grounding, and other Techniques for Electromagnetic Compatibility and Safety

STANDARDS (con't)

MIL-STD-1399, Section 300A with Notice 1 dated 11 March 1992 - Interface Standard for Shipboard Systems, Section 300A, Electric Power, Alternating Current

MIL-STD-1627C dated 30 September 1994 - Bending of Pipe or Tube for Ship Piping Systems

2.2.2 Other Government Documents, Drawings, and Publications

The following other Government documents, drawings, and publications form a part of this document to the extent specified herein.

PUBLICATIONS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

S9074-AR-GIB-010/278 - Requirements for Fabrication Welding and Inspection and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels

S9074-AQ-GIB-010/248 - Welding and Brazing Procedure and Performance Qualification

T9074-AS-GIB-010/271 - Requirements for Non-Destructive Testing Methods

S9073-A2-HBK-010 - U.S. Navy Resilient Mount Handbook

S9078-AA-HBK-010/DIM - Mount Design Handbook, Distributed Isolation Material (DIM) Navy - A Users Guide of Design, Procurement, Install and Inspection Info

S6430-AE-TED-010 – Technical Directive for Piping Devices, Flexible Hose Assemblies

0900-LP-001-7000 with Change 1 dated January 1981 - Fabrication and Inspection of Brazed Piping Systems

MIL-HDBK-267 – Guide for Selection of Lubricants and Hydraulic Fluids for use in Shipboard Equipment

803-1385850J - Piping, Instrument Pressure for all Service

803-1385884 - Unions, Fittings and Adapters, Butt and Socket Welding, 6000 PSI WOG NPS

NAVAL MEDICAL COMMAND

P-5010-6 (0520-LP-206-6300) - Chapter 6 – Water Supply Afloat

NAVMEDCOM Instruction 6240.1 – Standards for Potable Water

FEDERAL SPECIFICATION

QQ-N-00286F - Nickel Copper Aluminum Alloy, Wrought (UNS N05500), 29 November 1990

2.3 Non-Government Publications

The following documents form a part of this statement of work document to the extent specified herein.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

B15.1 - Mechanical Power Transmission Apparatus, Safety Standard for

B16.5 - Pipe Flanges and Flanged Fittings

NSF 60 - Drinking Water Treatment Chemicals - Health Effects

NSF 61 - Drinking Water Systems Components - Health Effects

ANSI/IEEE 315A dated 31 October 1975 - Graphic Symbols for Electrical and Electronics Diagrams

ANSI/ISO/ASQC Q9001-1994 - Quality Management Systems-Requirements

ANSI/ISO/ASQC Q9002-1994 – Quality Systems – Model for Quality Assurance in Production, Installation, and Servicing

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME Boiler and Pressure Vessel Code, Section VIII Division I - Pressure Vessels

ASME Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications

ASME Boiler and Pressure Vessel Code, Section X - Fiber-Reinforced Plastic Pressure Vessels

B31.1 - Power Piping

Y14.1 - Decimal Inch Drawing Sheet size and Format

Y14.2M - Line Convention and Lettering

Y14.3M - Multiview and Sectional Drawings

Y14.5M - Dimensioning and Tolerancing

AMERICAN SOCIETY FOR TESTING MATERIALS (ASTM)

A 354-00a - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

A 380-99 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment and Systems

A 563-00 - Standard Specification for Carbon and Alloy Steel Nuts

A967-99 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts

B861-00 - Specification for Seamless and Welded Titanium and Titanium Alloy Pipe

D512-89 - Method of Test for Chloride Ion in Industrial Water and Industrial Waste Water

D1125-95 - Standard Test Methods for Electrical Conductivity and Resistivity of Water

D1141 - Substitute Ocean Water, Specification for

D4189-95 - Standard Test Method for Silt Density Index (SDI) of Water

D4516-95 - Standard Practice for Standardizing Reverse Osmosis Performance Data

F467-98 - Standard Specification for Non-Ferrous Nuts for General Use

F468-98 - Standard Specification for Non-Ferrous Bolts, Hex Cap Screws, and Studs for General Use

F593-98 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

F594-98 - Standard Specification for Stainless Steel Nuts

F992-86 - Specification for Valve Label Plates

F1166-95a - Human Engineering Design for Marine Systems, Equipment, and Facilities

F1508-96 - Specification for Angle Style, Pressure Relief Valves for Steam, Gas, and Liquid Use

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

ICS 1 - General Standards for Industrial Control and Systems

ICS 2 - Industrial Control Devices, Controllers and Assemblies

ICS 3.1 - Handling, Storage, and Installation Guide for AC General Purpose Medium Voltage Contactors and Class E controllers, 50 and 60 Hertz

ICS 4 - Terminal Blocks for Industrial Use

IEEE 45 dated 19 October 1998 - Recommended Practice for Electric Installations on Shipboard

MG 1 - Motors and Generators

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

1910.219 - Mechanical Power-Transmission Apparatus

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

J121 - Decarburization in Hardened and Tempered Unified Threaded Fasteners

J1453 - Specification for O-ring Face Seal Fitting

J1926/1 - Specification for Straight Thread O-ring Boss Ports

HYDRAULIC INSTITUTE

American National Standard for Reciprocating Power Pumps

MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVE AND FITTING INDUSTRY

MSS SP-119 - Bell End Socket Welding Fittings, Stainless Steel and Copper Nickel

2.4 Order of Precedence

In the event of a conflict between the text of this statement of work document and the references cited herein (excluding the specifications), the text of this statement of work document takes precedence. Nothing in this statement of work document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3.0 DETAIL REQUIREMENTS

3.1 Characteristics

The RO unit shall be capable of producing freshwater (potable grade) from seawater under all conditions of salinity, temperature, and Silt Density Index (SDI) as specified in para. 3.3.3. The unit shall require minimal operator attention and manning as specified in para. 3.4.1. The RO desalination unit shall be an electrically operated, package-type (skid mounted) unit ready for operation after installation aboard ship. The RO desalination unit shall be designed such that the envelope size for the complete 1,200 GPD unit shall be no greater than 62 inches tall, 34 inches wide, and 29″ deep. The RO unit shall be designed such that all the access for unit operation and maintenance will be from the front of the unit (34 inch width) and require no more than a 62″ tall, 34″ wide by 28″ deep maintenance envelope. There will no access to the sides, top, or rear of the RO unit when installed aboard ship. No permanent part of the RO shall extend into the maintenance access envelope area at the front of the unit. The dry weight of the unit shall not exceed 1600 lbs. The contractor installing the RO unit will be responsible for installing the piping and electrical cables interconnecting the RO unit with the machinery control console, power panels, and ship fluid systems using an installation procedure provided by the RO unit manufacture.

3.1.1 Ship Interface Connections

Piping interfaces shall terminate at the side edges of the RO unit boundary. Ship interface connections shall not terminate at the rear, top, or bottom edges of the unit. The size and location of the terminal connections shall match the attached piping size and terminate with a flanged mechanical joint. All low pressure piping system interface flanges shall be fabricated from bronze materials, in accordance with MIL-PRF-20042E, (copper nickel piping systems only) or the same material as the piping and dimensionally in accordance with ASME/ANSI B16.5 or with Mil. Spec. MIL-PRF-20042E dated 16 September 1999 for non-ferrous alloy flanges with a flat face flange facing and non-metallic gaskets. The connections for the seawater feed supply, brine discharge, freshwater flush supply, and permeate outlets shall be located on the unit lower right side of the perimeter. The common unit gravity drain connection for the complete system and the LP air supply (if used) shall be located either the right or left side edge of the envelope. The piping

interface connections shall not be located such that they will interfere with RO unit maintenance. The following piping interfaces shall be required:

a. **Seawater supply to the unit.-** RO system shall be supplied with single 3/4″ NPS seawater supply located on the lower right side perimeter of the unit. This seawater supply will be provided from a pressurized firemain system maintained at 95 to 150 psi. The RO unit shall be designed to operate with a seawater supply pressure within this range without the need for a pressure reducing station. Piping class shall be 200 with 150 psi flanges. The low pressure seawater supply inlet piping system design pressure shall be at least 150 psi.

b. **Brine discharge overboard.-** One 1/2″ NPS interface connection for the RO unit, located on the lower right side perimeter, shall be provided. Piping design pressure shall be 50 psi.

c. **Permeate discharge to storage tank.-** One 1/2″ NPS interface connection for the RO unit, located on the lower right side perimeter, shall be provided. Piping design pressure shall be 50 psi.

d. **Permeate discharge to waste.-** One 1/2″ NPS interface connection for the RO unit, located on the lower right side perimeter, shall be provided. Piping design pressure shall be 50 psi.

e. **Gravity drain.-** One 3/4″ NPS interface connection shall be provided for the RO unit. Pretreatment, high pressure pump, and system/component drain/vent and pump gland cavity drains, as necessary, shall be combined into a single connection for connection to the ships gravity waste water drain system. Piping design pressure shall be 50 psi.

f. **De-chlorinated freshwater flush supply.-** One 1/2″ NPS interface connection for the RO unit, located on the lower right side perimeter, shall be provided. Normal freshwater supply operating pressure shall be 40 psi, maximum operating pressure shall be 50 psi. Piping system design pressure shall be 50 psi.

g. **Low Pressure (LP) air supply.-** One ¼″ NPS or female straight thread interface connection for the RO unit shall be provided for the RO unit if needed. Normal LP Air supply pressure will be 100 psi. Piping system design pressure shall be 150 psi.

3.1.2 System Requirements

The RO unit shall include the appropriate piping components (piping, fittings, valves, check valves, relief valves, etc.), pumps, and flowmeters to ensure that the following requirements, at a minimum, are satisfied:

a. Isolating, draining, and re-filling the filter vessel(s) to permit cartridge filter replacement.

b. Automatically back-flushing and rinsing the media filter.

c. Protecting the brine, permeate, and high pressure seawater feed systems from over-pressurization.

d. Isolating the seawater feed to the RO unit.

e. Maintaining seawater feed pressure to the HP pump within the limits prescribed by the pump manufacturer.

f. Automatically freshwater flushing the RO unit whenever the unit is secured or weekly when the unit has not been operated.

g. Automatically flushing the RO unit media filter weekly when the unit has not been operated.

h. Preventing the brine and permeate from back-flowing into the RO unit.

i. Measuring the brine (or feed) and permeate flow rates of each pass in GPM and the cumulative total of final permeate produced in gallons.

j. Venting of entrained air from incoming feedwater.

k. Minimizing entrapped air in the RO unit.

l. Permitting the continuous operation of the RO unit when salinity monitoring device is removed for repair or replacement.

m. Collecting unit drainage (pump shaft/plunger seal leakage, relief valve discharge, filter vessel drainage, piping, and component drainage as necessary) to a common point.

n. Discharging permeate overboard through a dedicated connection.

3.1.3 Shelf Life

Shelf life capability of the RO system shall be no less than 12 months. Shelf life is the period of time from delivery until system startup. Following the shelf life period the RO shall still have the specified operational service life without component or part replacement, adjustment, or maintenance action.

3.2 Qualification

RO units furnished under this statement of work document shall be products that are manufactured in accordance with the inspection requirements of either para. 3.2.1 or 3.2.2.

3.2.1 First Article

A sample unit shall be subjected to first-article inspection along with other tests and requirements as specified in para. 4.3.

3.2.2 Quality Conformance

The RO unit shall be subjected to quality conformance inspection in accordance with para. 4.4, which includes an 8-hour operational test.

3.2.3 Configuration Changes

Any modifications to a previously qualified design RO unit shall be the basis for repeating first article testing (see para. 3.2.1) of the entire unit or component. The Contractor may request from the procuring activity a waiver of all or part of the first article tests. The request shall provide a technical rationale for the waiver. The procuring activity shall make the final determination on the waiver request.

3.3 Performance Requirements

3.3.1 Capabilities

When operating at specified environmental conditions (see para. 3.3.6) and within the specified pressure limits (see para. 3.3.2), the RO desalination unit shall be capable of producing acceptable quality permeate (see para. 3.3.4) over the entire range of specified seawater conditions (see para. 3.3.3). Production rate under various seawater conditions shall be in accordance with para. 3.3.1.1. In addition, the RO unit shall remain on-line, producing acceptable quality permeate (see para. 3.3.4) with seawater temperature swings of 18 degrees F without operator interface.

3.3.1.1 Permeate Production Rate

The design capacity of the RO unit, with a first pass 0.85 membrane fouling factor or the equivalent applied, shall be 1,200 GPD with a seawater feed salinity of 45,000 ppm and feed temperatures between 75 degrees F and 104 degrees F. The maximum first pass permeate recovery shall not exceed 26 percent. For a 60 degrees F seawater feed temperature and feed salinity of 45,000 ppm, the production rate shall not be less than 800 GPD. At the feed salinity of 45,000 ppm and a feed temperature of 75 degrees F the unit shall be capable of meeting full rate without exceeding the allowable operating pressure. A means shall be provided for ensuring uniform permeate flow rate over time such that a variation in permeate flow does not deviate by more than ± 1 percent of the nominal set value during any 15 minute operating period. Brine/concentrate throttling devices shall be utilized to ensure uniformity of flow with operating time. Gate and ball valves shall not be used for throttling. The maximum permeate and brine back pressure on the RO unit is expected to be 15 psi.

3.3.2 Operating Pressure

The RO unit operation shall not exceed RO membrane element manufacturer's operating pressure limitations.

3.3.3 Natural Seawater Feed Characteristics

For design purposes, natural seawater feed entering the RO unit shall be considered to have the following characteristics.

SEAWATER PROPERTIES	CHARACTERISTIC
Total Dissolved Solids (TDS)	25,000 to 45,000 ppm
Maximum Silt Density Index (SDI) (15 minutes) (ASTM D 4189)	6.0
High density suspended solids (specific gravity >1.7, size >75 micron)	20 ppm (nominal)
Low density suspended solids (specific gravity <1.7, size <75 micron)	30 ppm (nominal)
pH range	7.0 - 8.4
Temperature range	35 – 104°F

3.3.4 Permeate Water Quality

The permeate (freshwater) quality shall meet the requirements of NAVMEDINST 6240.1 and NAVMED P-5010-6 and that permeate salinity be 25 ppm TDS or fewer. With new membranes installed and operating with 45,000 ppm seawater feed, permeate salinity shall not exceed 20 ppm TDS throughout the seawater inlet temperature range given in para. 3.3.3.

3.3.5 Service Life

Each unit shall be designed for a useful service life of 20 years without a failure of the following major components: RO pressure vessels (including end caps), media and cartridge filter housings, strainer housings, centrifugal separator, high-pressure pump casing(s), pulsation reduction device housings, piping and unit frames and base(s).

3.3.6 Environmental Conditions

Each unit shall be designed for operation at ambient air temperatures between 60 and 125 degrees F. Seawater splashing onto the unit can be expected to occur during filter element replacement.

3.4 Operation

3.4.1 Normal Operation

RO unit shall be designed to start-up and produce the specified quantity and quality of permeate within 15 minutes or less. Normal operation shall require no more than 5 minutes of single operator attention for every 4 hours of operation. The maximum time for normal shutdown, including freshwater flushing, is 20 minutes. See para. 3.5 for description of control and indication system.

3.4.2 Monitoring

A means shall be provided to monitor the first pass permeate. A means shall be provided to monitor and automatically divert high TDS final permeate (as specified in para. 3.3.4) to waste and to ensure that the unit shall continue to operate during this time. A means shall also be provided for manually (not automatically) redirecting permeate from waste line back to the freshwater tanks when permeate readings are acceptable. The monitoring system

and the components to automatically divert high TDS permeate shall meet paras. 3.5.2, and 3.19.14.

3.4.3 Startup/Shutdown

The unit shall be started manually until operating normally and producing acceptable quality permeate as specified in para. 3.3.4. The unit shall be automatically monitored for abnormal conditions by controls and indicators as specified in para. 3.5 and shall automatically shutdown when any one of the shutdown conditions identified in Table I is encountered. Once the operator has corrected the problem, the unit shall be restarted manually. Fully automatic restarts shall not be allowed, except when back-flushing the media filter.

3.4.4 Restrictions on Use of Chemicals

The use of chemicals is prohibited for normal operation in order to minimize Hazardous Material (HAZMAT) storage, handling aboard ship, and discharge. Chemicals may be provided for use in the event that cleaning of membrane elements is necessary (see para. 3.19.20) following mineral scale, organic or hydrocarbon contamination. Such cleaning, however, is not to be construed as a normal operational procedure. Installation of a permanently mounted cleaning tank is not required.

3.4.5 Energy Consumption

The RO unit shall produce the specified rate of permeate with an energy consumption of 80 BTU/lb (convert to BTU/gal) permeate or less. Energy consumption shall be calculated on the basis of the pumping energy consumed by electrical motors and the electrical power consumed by other electrical components used in the process of desalinating the feed seawater at a salinity of 45,000 ppm TDS and 75 degrees F temperature.

3.5 Controls and Indicators

Monitor, alarm, startup and shutdown functions for the RO unit shall be centralized on a Human Machine Interface (HMI) flat panel display. Aligning unit for operation, manual activation of media filter back-flush and rinse, seawater feed, freshwater flush, freshwater flush pump start/stop, permeate dump valve test and activation shall be provided from the HMI. The minimum instrumentation for a reverse osmosis unit shall be as listed in Table I and para. 3.5.1.4. Installation shall be as detailed in para. 3.20. The interface shall display the first out indication where only the first condition to cause a summary fault or alarm is indicated prior to acknowledging the alarm. The HMI shall also provide access to a history of unit alarm condition and frequency of media filter back flush and unit freshwater flush history. Dedicated circuits shall be provided for each of the remote indications as listed in Table I. Dedicated circuits, rated for 120VAC/28VDC using internal normally open or external normally closed contact circuits, shall be provided for remote indication of unit status (RO unit operating or secured), summary fault, summary alarm, salinity dump valve position, remote commanded unit emergency shutdown (without freshwater flushing), freshwater flush pump start/stop and salinity dump valve actuation (remote powered signal). Analog signals for high pressure pump discharge pressure (4-20mA) and permeate salinity (0-1mA isolated signal) shall be provided. Each of these circuits will be connected to a dedicated data acquisition/command interface to the ships machinery control system and displayed or controlled from the ships machinery control consoles. Electrical controls and instrumentation shall not be located in areas where they could be exposed to fluid leakage during calibration and maintenance. The brine and concentrate back pressure control throttling devices shall be within direct line of sight of the permeate flow meter indications.

3.5.1 Installation

Pressure instruments and associated piping shall be installed as detailed in drawing, NAVSEA No. 803-1385850, Rev.J, dated 31 July 1990. In addition, the following shall apply:

a. Each instrument shall have an individual gage isolation and test valve. The isolation valve shall be in accordance with Mil. Spec. MIL-V-24578B dated 27 May 1988.

b. Instrument tubing below 1/4-inch outside diameter is prohibited.

c. Pressure connections for instrumentation shall be external threaded for “O-ring” face seal union in accordance or SAE J1453. Internal threaded connections to mechanical or electrical instrumentation shall be in accordance with SAE J1926/1. Tapered pipe threads are prohibited, except for freshwater systems with design pressures below 50 psig, provided the unit passes the shock and vibration testing requirements.

d. Materials selected for the fluid containing components shall be in accordance with para. 3.16.

e. Components shall meet the pressure rating and temperature of the fluid that is being monitored.

f. Instrument root valves are not required.

3.5.1.1 Pressure Instruments

Pressure gages, where used, shall use U.S. Customary (English) units of measurement. The range of scale chosen shall be such that the normal operating point is in the middle half (25 to 75 percent) of the scale. Pressure gages shall have a manually adjusting red-colored pointer in addition to the indicating pointer. The red hand shall be set at approximately the more critical maximum or minimum operating pressure for the applicable system. Pressure transducers, with remote readouts on the HMI, shall be used for all indications needed for monitoring and control of the RO unit. Snubbers, in accordance with Mil. Spec. MIL-PRF-2940D dated 13 April 1999, shall be provided in the sensing line to all transducer and to pressure gages subject to pulsation. Pressure instruments shall meet the visibility requirements of ASTM F1166.

3.5.1.2 Temperature Instruments

Thermometers shall use U.S. Customary (English) units of measurement. The range of scale chosen shall be such that the normal operating point is in the middle half (25 to 75 percent) of the scale. The accuracy shall be within ± 1 percent of the full scale. Thermometers shall conform to Mil. Spec. MIL-I-17244E with Notice 1 dated 7 June 1991. Thermometer first article testing in accordance with MIL-I-17244 may be waived provided the RO unit shock and vibration and endurance test requirements are met. Thermocouple and resistance temperature detector assemblies in accordance with Mil. Spec. MIL-T-24388C dated 30 March 1990, with remote readouts may be used in lieu of thermometers, provided the provisions in this section are met. Piping temperature instruments shall be installed in sockets (wells). Thermowells shall be 3/8 inch nominal bore diameter in accordance with Mil. Spec. MIL-T-24270B dated 2 September 1983. The temperature instrument shall meet the visibility requirements of ASTM F1166.

3.5.1.3 Not used

3.5.1.4 Manually operated switches

Manually operated switches and indicators shall meet the requirements of Mil. Spec. MIL-C-2212H dated 10 February 1997 or as detailed in para. 3.20. Table II lists typical switches, applicable indicators, and their function. Switches shall preclude inadvertent actuation, restarting of the unit or actuation of any electrical component after power is restored following a loss of power situation, and shall be readily accessible.

TABLE I.- LIST OF MONITORS, ALARMS, AND SHUTDOWNS

DESCRIPTION	INDICATION/ METER	ALARM INDICATION	RO UNIT SHUTDOWN	REMOTE INDICATION
Pressure				
Feedwater supply	X			
Freshwater flush supply	X	LO	LO	Summary fault (when flushing)
Permeate discharge press	X			
HP pump suction	X		LO	Summary fault
HP pump discharge	X		HI	Summary fault Analog Signal
Media and Cartridge Filter				
Inlet	X			
Outlet	X			
Differential pressure				
Cartridge Filter	X	HI		Summary alarm
Media Filter	X	HI (if not reset following backflush)		Summary alarm
Temperature				
Feed inlet	X			
Flow				
Feedwater or brine	X			
First Pass Permeate (gpm)	X			
Final Permeate (gpm)	X			
Final Permeate (totalizing)	X			
Salinity				
First pass conductivity	X			
Final permeate conductivity (trips dumping system)	X	HI		Summary alarm Analog Signal
High pressure pump overload			Overload	Summary fault
Elasped operating time	X			
Permeate Sterilizer Failure		X		Summary alarm

TABLE II.- LIST OF MANUAL SWITCHES (TYPICAL)

SWITCH DESCRIPTION	LAMP	FUNCTION
Start/Stop	X	Energizes system to operate and start HP pump (provided all pump permissives are met)/Secures system and initiates fresh water flush
Normal/Manual Operation		Allows operation with control system bypassed.

3.5.2 Salinity Indicating System

The equipment shall have the ability to monitor first pass and final permeate conductivity and activate the final permeate dump valves and HMI indicators and alarms. A high salinity condition shall actuate an audible alarm in addition to the summary alarm and high salinity indication. The meter range shall be in either micromhos/cm or microSiemens/cm. The salinity monitor shall be fully temperature compensated. A completely isolated 0–1 mA DC analog output shall be provided for remote indication of the salinity reading. The salinity cell installation shall allow for removal of the salinity cell and manual sample collection while the RO system is operating for maintenance and repair. Salinity cell removal shall be accomplished without having to twist the attached cable.

3.5.2.1 Mounting

Salinity system monitor shall be either incorporated into the control system cabinets or mounted adjacent to the control system enclosure.

3.5.2.1.1 Identification

Identification plates for the salinity cells shall be attached to the cell body. The following minimum information shall be provided:

SALINITY MONITOR	SENSOR
Manufacturer’s name and serial number	Manufacturer’s name and serial number
Ratings and range	Cell constant
Part number	Part number

3.5.2.3 Operating Instructions

Instructions for operating and interpreting all controls and indicators of the salinity indicating equipment shall be indicated on the HMI. At a minimum, the following instructions shall be provided:

a. Testing the conductivity monitor and dump valve operation.
b. Acknowledging an alarm condition.
c. Resetting and alarm condition and re-activating the dump valve.

3.5.2.4 Salinity Monitor Cooling

Monitor cooling shall be accomplished using only external natural air convection circulation. Fluids other than natural convection air are prohibited.

3.5.2.5 Access to Internal Parts

Ready access to all internal parts shall be obtained through the hinged front door of the control panel.

3.5.2.6 Alarm Level Control

A means shall be furnished for checking monitor operation on the HMI so that the operator can observe the visual and audible alarm signal and dump valve actuation.

3.5.2.7 Alarms

The characteristics of both the audible alarms and visual displays shall be in accordance with ASTM F1166.

3.5.2.8 Dump Valve

The salinity indicating system shall be provided with the means to automatically actuate an independent, solenoid operated dump valve to divert high TDS water overboard via a sight flow indicator. An indicator shall

illuminate on the HMI whenever the dump valve is diverted to discharge overboard.

3.5.2.9 Accuracy

The accuracy of the salinity indicating equipment shall be as follows:

a. Salinity monitor accuracy (simulated input at the monitor) plus or minus 3 percent of full scale meter arc.

b. System accuracy (actual input from sensors). The salinity monitor meter shall duplicate the standard reference instrument within plus or minus 5 percent of monitor meter full scale arc in accordance with para. 4.5.16.3.

c. Sensor cell constant accuracy - plus or minus 2 percent when tested in accordance with method A of ASTM D1125.

d. Alarm accuracy plus or minus 5 percent of set point.

3.5.2.10 Sensor Temperature Compensator Response

The time required to reach 63 percent of a 50 degrees F change in fluid temperature (that is, 63 percent of the difference in resistance between stabilized baths) shall be less than 30 seconds (see para. 4.5.16.2).

3.5.2.11 Overrange

The salinity indicating equipment shall be capable of being overranged, including having a short circuit across sensor electrodes, temperature compensator, and both electrodes and temperature compensator without damage to sensor or salinity monitor (see para. 4.5.16.4).

3.5.2.12 Calibration

The salinity monitor calibration procedures and test equipment using test resistors shall be provided.

3.6 Preventative Maintenance and Repair

Maintenance actions and repairs, with the exception of motor rewinding, shall be capable of being performed on board ship using the available access detailed in Para 3.1. The following accessibility requirements shall apply:

a. All major test points, adjustments and servicing points peculiar to the unit shall be readily accessible without the need to first remove obstructions. Any component that is subject to periodic inspection or replacement shall, likewise, be readily accessible without the need to remove obstructions.

b. Warning labels shall be readily visible and readable by the operator while standing or kneeling adjacent to the unit. These plates shall be mounted on or adjacent to the unit.

c. Unit components that weigh more than 44 pounds and are removable for maintenance or in-place repair shall have lift lugs, eyes, or pads.

3.6.1 Preventative Maintenance

Preventative (scheduled) maintenance, except for a daily visual inspection, shall be required no more than once every 7 days.

3.6.2 Repair

Requirements for non-standard size and special tools, jigs, and fixtures shall be kept to a minimum. Those special tools, jigs, and fixtures that are required for maintenance or repair shall be supplied with the RO unit. Special tools are defined as those items not listed in the Federal Supply Catalog. The unit shall be designed to allow for disassembly and re-assembly without the need for welding when replacement of components is required.

3.7 Reliability

The Contractor shall provide a standard warranty for the RO system for a minimum period of one year from activation aboard ship. The RO unit shall meet or exceed the following requirements:

Mean-Time-Between-Failure (MTBF)(operating hours)	2000
Operational availability-A_0 (percent)	99
Unit design life (years)	20
Mean-Time-To-Repair (MTTR) (hours)	3.0
Maximum-Time-To-Repair (Mmaxct) (hours)	6.0
Mean-Preventative-Maintenance-Time (Mpt) (hours)	0.5
Maximum-Preventative-Maintenance-Time (Mmaxpt) (hours)	1.0
Minimum time between overhauls (pump only) (operating hours)	10,000
Mean maintenance time (hours per month continuous operation)	2.0

3.8 Hydraulic Pressure

All components of the unit which are exposed to positive pressure, with the exception of the membrane elements, shall withstand, without plastic yielding, permanent deformation, or malfunction (leakage and so forth), a hydrostatic test pressure of 1.5 times the design pressure of the item for no less than 30 minutes.

3.9 Interchangeability

In no case shall parts (except for the first and second pass membranes) be physically interchangeable or reversible unless such parts are also interchangeable or reversible with regard to function, performance, and strength.

3.10 Electromagnetic Interference

The RO unit shall meet the electromagnetic interference (EMI) requirements of MIL-STD-461E dated 20 August 1999 for surface ship equipment mounted below deck.

3.11 Not used.

3.12 Vibration Requirements

The complete RO system shall meet the requirement of MIL-STD 167-1 for the frequency range of 4 to 50Hz. Reciprocating type high pressure pumps (if used) shall also be analyzed and tested for Type III torsional vibration in accordance with MIL-STD-167/2.

3.13 Requirements Due to Ship Attitude or Motion

The complete RO system assembly shall be mounted with the long axis in the forward/aft alignment. The unit shall maintain design performance without damage or degradation when under the following conditions:

- When the ship is permanently trimmed down by the bow or stern as much as 7 degrees from the normal horizontal plane.
- When the ship is permanently listed up to 15 degrees to either side of the vertical.
- When the ship is pitching 15 degrees up or down from its normal horizontal plane with a period of 9 seconds.
- When the ship is rolling up to 35 degrees to either side of the vertical with a period of 9 seconds.

3.14 Vibration Control

Resilient mounts shall be provided for the high pressure pump base, attached components. Resilient mounts shall be selected and installed in accordance with publication, S9073-A2-HBK-010. Distributed Isolation Material (DIM), resilient or Government-approved mounts maybe used to further

isolate the high pressure pump from the ship's structure (see paras. 3.19.24 and 3.19.25). These DIM mounts (if used) shall be provided with the RO unit.

3.15 Identification Plates

The RO unit shall bear an identification plate with the following information:

a. Item identification (equipment title, serial number, part number)
b. Size (1,200 GPD)
c. Name and address of manufacturer
d. Contract or order number (use width of plate to allow maximum number of spaces)
e. National stock number (allow 20 spaces)
f. Date of manufacture.

Label plates shall be clearly legible, permanently secured, and shall last for the life of the RO unit.

3.15.1 Valve Identification Plates

Valves shall be marked in accordance with ASTM F992, with the valve function or description and the valve number identified in the flow schematic.

3.15.2 Information Plates

Information plates shall be provided for the complete system and shall include, but not be limited to: startup and shutdown procedures and flow schematics. A single set of these plates shall be provided with the RO system for mounting by the installation contractor. Information plates shall meet the visibility requirements of ASTM F1166.

3.16 Materials

Materials used in the RO unit shall be compatible with the environment in which they will operate and provide the desired service life. The maximum general corrosion rate or pitting corrosion rate shall be limited to 2 mils per year (mpy) for those internal surfaces and materials used to contain, carry or transport seawater. Acceptable metallic materials and fittings for contact with seawater are nickel-aluminum-bronze, valve bronze, 90-10 or 70-30 copper-nickel, monel, titanium, Superaustenitic alloys such as AL-6XN (UNS N08367), SMO-254 (UNS S31254), or cast 20Mo6 (UNSJ94631), Superduplex alloy type 2507 (UNS S39275), or Ni-Cr-Mo-Fe alloy such as Hasteloy C276 (UNS N10276), C-22 (UNS N06022), C-2000 (UNS N06200), 59 (UNS N06059), or 686 (UNS N06686). Acceptable metallic materials and fittings for contact with seawater during normal operation and flushed with freshwater while unit is secured also include alloy 20, CD4MCu and CN7M. All stand-alone non-metallic materials that may come in contact with permeate shall be ANSI NSF 60 and NSF 61 approved. This includes thread lubricants, O-ring lubricants, and hoses. This requirement does not apply to non-metallic parts contained inside a metallic component such as valve packing or soft seat materials.

3.16.1 Excluded Materials

3.16.1.1 Stainless Steel

Austenitic stainless steels (UNS 300 and 400 series) and high ferrous alloy steels shall not be used in any components or piping used for containing, carrying, or transporting seawater, first pass permeate, second pass concentrate, or brine. Use of austenitic stainless steel allows is permitted for components or piping carrying or transporting second pass permeate.

3.16.1.2 Copper-silicon Fasteners

Copper-silicon and silicon-bronze fasteners shall not be used.

3.16.1.3 Mercury

RO units shall contain no mercury in any form. No mercury-bearing instruments or equipment, except for mercury-vapor lighting, that might cause contamination shall be used in the manufacture, fabrication, assembly, or testing of any material. In the event of any accident involving mercury contamination of the material being furnished or suspicion of such contamination, notify procuring activity immediately.

3.16.1.4 Magnesium and Aluminum

Magnesium and magnesium alloys shall not be used in any component. Aluminum and aluminum alloys shall not be used for water-wetted applications.

3.16.1.5 Cadmium Plating

Cadmium plating shall not be used on any component.

3.16.1.6 Plastics

Toxic materials such as polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polybutadienes (PB), polyethylene (PE), and acrylonitrile-butadiene-styrene (ABS) shall not be permitted to be used in any component of the RO unit because of fire hazard. Membrane elements contained within a pressure vessel are excluded from this requirement.

3.16.1.7 Silicone

To eliminate the potential for fouling the RO membrane, the use of silicone lubricants and sealants shall be minimized anywhere they can come in contact with the direct feed to the membranes. Where silicone is in contact with the direct feed to the membranes, guidance shall be provided to ensure sparing application of the silicone.

3.16.1.8 Lead

Lead and its compounds shall not be used where they can come in contact with seawater feed, permeate, or freshwater. The lead content in bronze alloys shall not exceed levels allowed by ASTM B61. Leaded bronze alloys shall not be used.

3.16.1.9 Recycled, Recovered, or Environmentally Preferable Materials

Recycled, recovered, or environmentally preferable materials shall be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.16.2 Corrosion Prevention/Control

For seawater wetted components, mating materials shall be galvanically compatible as mating materials having electromotive force (emf) difference less than 200 millivolts (mV). Where the materials are not compatible within 200 millivolts (mV), they shall be properly isolated. Paint shall not be considered an appropriate insulator for this application.

3.16.3 Moisture and Fungus Resistance

The unit shall be designed so that its constituent materials are not nutrients for fungi. The materials used, other than the RO membranes and filter media, shall not absorb and hold moisture. No materials used in the RO unit shall degrade in the presence of moisture.

3.16.4 Lubricants

Lubricants and/or hydraulic fluids shall be selected from those standard lubricants and hydraulic fluids listed in MIL-HDBK-267. Components and equipment that do not require relubrication by ship’s force during routine maintenance between overhauls are not required to utilize a standard

lubricant. The use of lubricants not listed in MIL-HDBK 267 will require written approval from NSWC.

3.17 Fabrication

3.17.1 Welding and Brazing

Welding and inspection of pressure vessels, castings and piping shall meet the requirements of publication, NAVSEA S9074-AR-GIB-010/278. Joint design shall meet the requirements of MIL-STD-22D dated 31 January 1984. There shall be no pockets, crevices, porosity, or notches, which could become points of stress concentrations. The use of backing strips in pressure vessels shall not be permitted. Silver-brazed piping joints shall be accomplished in accordance with publication, NAVSEA 0900-LP-001-7000. Silver brazed piping joints are not permitted in class P-1 piping or A-1 pressure vessels per NAVSEA S9074-AR-GIB-010/278. Any brazing alloy containing less than 43 percent silver shall not be permitted. All structural welding and inspection shall meet the requirements of publication, NAVSEA S9074-AR-GIB-010/278. Requirements for nondestructive testing shall conform to publication, NAVSEA T9074-AS-GIB-010/271. Welding procedure and welder performance qualifications shall be accomplished in accordance with publication, NAVSEA S9074-AQ-010/248.

3.17.2 Casting Inspection and Repair

Inspection and repair of castings shall meet the requirements of sections 12 and 13 of publication, NAVSEA S9074-AR-GIB-010/278. Requirements for nondestructive testing shall conform to publication, NAVSEA T9074-AS-GIB-010/271.

3.17.3 Pressure Vessels

All pressure vessels, except for cast metallic strainer bodies (if used) shall meet the regulations of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or Section X, Class I, but do not require ASME stamping regardless of size or pressure. Glass Reinforced Plastic (GRP) pressure vessel attachments and supports, if used, shall meet the performance requirements of ASME, Section X, Appendix AA-5.

3.17.4 Frames and Bedplates

The frames and bedplates used to mount the RO unit components shall not contain pockets where moisture can accumulate. A means for lifting removable frames and bedplates shall be provided.

3.17.5 Threaded Parts

Threaded fasteners shall be in accordance with Mil. Spec. MIL-S-1222G dated 29 December 1980. Seawater piping flange fasteners shall be a nickel copper alloy. Other piping flange fasteners and any piping support fasteners or U-bolts shall be corrosion resisting steel. Other component fasteners may be either a nickel copper, corrosion resisting steel, or grade 5 or 8 alloy steel where bolting strength is paramount. Nickel copper (Monel) 400 alloy ASTM fastener systems in accordance with ASTM F467 and 468 maybe used as an alternate to Mil. Spec. MIL-S-1222G dated 29 December 1980. Nickel copper aluminum (K-Monel) 500 alloy ASTM fastener systems in accordance with ASTM F467 and ASTM F468 maybe used as an alternate to Mil. Spec. MIL-S-1222G dated 29 December 1980 provided the materials are in accordance with Fed. Spec. QQ-N-00286F dated 29 November 1990. Stainless steel ASTM fastener systems in accordance with ASTM F593 and 594 may also be used as an alternate to Mil. Spec. MIL-S-1222G dated 29 December 1980 provided fasteners are passivated in accordance with ASTM A380. Grade 5 or 8 alloy steel ASTM fastener systems in accordance with ASTM A354 and 563 may also be used as an alternate to Mil. Spec. MIL-S-1222G dated 29 December 1980 provided fasteners are subject to decarburization testing that is performed on one sample per lot in accordance with SAE J121, Class B where each lot is defined as a heat treatment furnace

load. In addition, ASTM A563 inspection lot sizes and sampling shall be modified to require 2 samples per lot for 50 pieces or less lot sizes, and 3 samples for lots with 50 or more pieces. The complete lot shall be rejected if 1 nut fails to meet the test criteria. Straight thread O-ring fittings shall meet the requirements of SAE J1926/1. The use of non-standard threaded fasteners is prohibited.

3.17.6 Painting

RO unit components shall be painted before assembly in accordance with the following:

a. Resilient mounts and hoses shall not be painted.

b. The total paint system shall last a minimum of 10 years without blistering, cracking, pealing, or flaking.

3.18 Safety

The unit shall be designed so as to be free of personnel hazards. All safety features shall be such that their functions cannot be inadvertently degraded or negated during operation, storage, shipping, handling, or maintenance. All parts, components, and assemblies of the RO shall be free from sharp edges, burrs, protruding surfaces and other harmful extraneous material. Means shall be provided to ensure against damage to wires and cables from contact with rough or irregular surfaces and sharp edges.

3.18.1 Human Engineering

The unit design shall incorporate the human engineering requirements of ASTM F1166.

3.19 Components

The following equipment and component requirements shall apply.

3.19.1 Piping

Piping, valves, fittings, and associated piping components shall meet the requirements of ASME B31.1, except as modified herein. In addition to brazing flanges, allowed in ASME B31.1, welded copper nickel flanges of either the slip-on or weld-neck design are acceptable provided that interface geometry is unaffected. All low pressure piping system flanges shall be dimensionally in accordance with ASME/ANSI B16.5 or with Mil. Spec. MIL-PRF-20042E dated 16 September 1999, for non-ferrous alloy flanges, with a flat face flange facing and non-metallic gaskets. High pressure piping flanges shall also be dimensionally in accordance with ASME/ANSI B16.5 with either a raised face flange face and suitable spiral wound gasket or a grooved flat face design and fluorocarbon or EPDM O-ring seal. Union fittings, when used for high pressure piping take down joints, shall be in accordance with drawing, NAVSEA No. 803-1385884. Piping weld joints shall be in accordance with MIL-STD-22D dated 31 January 1984. Low pressure union fittings shall be in accordance with to Mil. Spec. MIL-F-1183J dated 5 May 1987 for copper nickel piping systems or conform dimensionally but be configured for socket welding and fabricated from the same material used in the piping system. Other methods and types shown in ASME B31.1, Paragraph 104.3 illustrates the desired principles of branch connections. Pipe socket welded joints shall be limited to 2-inch NPS and smaller. The use of miter joints or welded pipe branch connections shall not be permitted for any pressurized piping systems. Use of bell end socket weld fittings in accordance with MSS SP119 all size low pressure piping sections fabricated from 70-30 copper nickel materials is also approved. Victaulic fittings maybe used if limited to joints that will not require disassembly for component repair or replacement over the life of the unit provided the RO unit shock and vibration requirements are met. Tapered pipe threads or 37 degree flare are not acceptable except for freshwater systems with design pressures below 50 psi and provided the RO unit shock and vibration requirements are met.

The desired configuration shall have all required ship piping interfaces compatible with 70-30 Copper Nickel piping and fittings. Maximum velocity for titanium, Superaustenitic or duplex, monel (Nickel-Copper), or Ni-Cr-Mo-Fe alloy pipe and component nozzles shall be 15 ft/sec with a minimum velocity of 4 ft/sec. To ensure minimal pipe wall loss due to erosion, all copper nickel piping shall be 70-30. Sizing of 70-30 copper-nickel seawater and brine piping (and composite material components if used) shall be such that during normal operation, seawater velocity will be maintained as follows:

MAXIMUM VELOCITY FOR 70-30 COPPER-NICKEL PIPE AND TUBING

DIAMETER SIZE (inch)	MAXIMUM VELOCITY (ft/sec)
1/2 OD	5.0
5/8 OD	6.0
3/4 OD	6.0
1/2 NPS	6.2
3/4 NPS	6.8
1 NPS	7.4
1-1/4 NPS	8.2
1-1/2 NPS	8.6

3.19.1.1 Pipe and Tube Bends

The bending and fabrication of bent pipe and tube assemblies shall be in accordance with MIL-STD-1627 except that post bend weld treatment shall be in accordance with ASME B31.1 instead of Section 6 of MIL-STD-1627. Pipe or tube bend radius shall be no less than 2 times the pipe outer diameter (OD). For pipe or tubing bent to a radius of less than 5 times the OD, the piping or tubing shall have an increase in wall thickness over the wall thickness required for straight piping or tubing of the same size, material, and pressure rating, such that the resulting hoop stresses in the front wall does not exceed the maximum allowable stresses specified in ASME B31.1. All bent pipes shall be free of wrinkles. Buckles, bulges, humps, steps or dents shall not exceed 3 percent of nominal pipe OD and shall blend smoothly in a gradual manner.

3.19.1.2 Connections to Resiliently Mounted Components

Hard piping connections are not permitted between stationary and resiliently mounted components.

3.19.2 Hoses

High-pressure hose shall meet the requirements of S6430-AE-TED-010 for hose installation. Hose installations shall have minimal static loading (for example no “U” or 90-degree bends are permitted). The use of pre-formed or cast hose shall be avoided. All high and low pressure hose end fittings shall be a reusable design that shall not use band clamps to secure the hose to fitting. All hose fitting end designs shall conform to either an approved piping union or flange, SAE J1453 for an O-ring face seal or a split clamp arrangement using a face seal O-ring joint. A threaded female type connection into a component shall utilize a SAE J1926 straight thread O-ring seal. Tapered pipe threads or 37 degree flare are not acceptable except for freshwater system hose connections with design pressures below 50 psi and provided the RO unit shock and vibration requirements are met. The service life for the hose shall be 15 years. Appropriate materials (see para. 3.16) shall be selected for the hose and fittings. Flexible hose assemblies shall have a safety factor of 4 to 1 based on the burst pressure relation to the rated working pressure. In other words, the burst pressure is 4 times the rated working pressure. Each hose shall be marked at repetitive intervals along the lay-line with the information listed as follows:

a. Manufacturer’s name or trademark

b. Size by dash number (The dash number is normally the hose inside diameter in 16ths of an inch.)

c. Quarter and year of cure or manufacture.

The hose manufacturer may include additional information provided the repetitive interval is maintained.

3.19.3 Pretreatment System

The RO unit seawater pretreatment system shall be sufficient to ensure that for incoming seawater having the properties listed in para. 3.3.3 shall continuously provide filtrate to the membranes having an SDI of 5.0 or less and turbidity of 1 nephelometer turbidity unit (NTU). Pretreatment system shall be designed such that the final cartridge filters will not require replacement at less than after 1080 hours of continuous or intermittent operation when the unit is properly flushed with freshwater. Individual component design requirements and recommendations are listed in paras. 3.19.5 and 3.19.6.

3.19.4 Strainer

A single Y or simplex strainer with 1/32″ mesh shall be provided with the RO unit. This strainer will be installed in the seawater feed system upstream of the RO unit. This strainer is installed by the installing activity and does not have to be included within the RO unit boundary.

3.19.5 Media Filter

A media type pre-filter shall be installed that automatically back flushes and rinses at a differential pressure set point and on a set periodicity. The filter shall be sized such that the media has a design life of at least 7,500 hours when operated on a seawater feed with the properties listed in para. 3.3.3. The control system shall be designed to automatically secure the RO unit when back-flushing is required and restart the unit automatically including automatically resetting the final permeate three-way dump valve to direct the final permeate to the ships potable water tanks when the back-flush and media filter rinse is complete. The media filter flux rate shall be no greater than 9 gpm per square foot of surface area. Back flush flow rate shall be approximately twice the normal feed flow rate. The rinse flow shall be approximately the normal feed flow rate. The media filter differential pressure shall be monitored and alarm condition displayed on the HMI when the filter differential does not drop below the reset point following a back flush. The media shall consist of the following granular semi-permeable standard material. The respective depth shall be specified by the RO unit manufacture.

Anthracite (top layer)
Effective size: 1.3-2.0 mm, Uniformity coefficient: 1.5-1.8
Anthracite (second layer)
Effective size: 1.0-1.6 mm, Uniformity coefficient: 1.5-1.8
Sand
Effective size: 0.4-0.8 mm, Uniformity coefficient: 1.3-1.8
Garnet
Effective size: 0.2-0.6 mm, Uniformity coefficient: 1.5-1.8
Gravel (distribution channel cover)
Effective size: 3-10 mm

3.19.6 Filters

A final cartridge type filter shall be installed upstream of the HP pump to provide final filtration and protect the pump and membranes from media carryover. Cartridge Filter elements available only from a single manufacturer are prohibited. Cartridge filer shall be sized with sufficient area to support a minimum cartridge life of 1080 hours when installed downstream of the upstream media filter. Filter elements shall be a standard 2 or 2.5 inches

diameter, 10 to 30 inch design. The filter differential pressure shall be monitored and alarm condition displayed on the HMI.

3.19.7 Pump Balancing

All moving components in reciprocating type pumps shall be balanced as necessary to meet the torsional vibration requirements of MIL-STD-167/2 dated 19 June 1987, type III. Clamped or glued weights are unacceptable.

3.19.8 Pump Motor Mounting

A means shall be provided for adjusting and aligning the pump to its driver. The pump and driver combination shall be mounted on a common platform. Direct coupled pumps shall be coupled to the motor using a dry type coupling that does not require lubrication. Belt driven pumps shall utilize a synchronous drive belt and sheave system.

3.19.9 Guards

Guards shall meet OSHA 1910.219 and ANSI B15.1 requirements for construction and safety.

3.19.10 Accumulators/Pulsation Dampeners

Accumulators and/or pulsation dampeners shall be used on all positive displacement pump designs and meet the requirements of Reciprocating Pump Standards of the Hydraulic Institute.

3.19.11 Permeate Sampling

A means shall be provided for obtaining samples of the permeate from each pressure vessel and from the combined final permeate discharge without disrupting the permeate output flow or dismantling piping or fittings.

3.19.12 Reverse Osmosis Element (Membrane) Isolation

A means shall be provided for isolating 100 percent of the installed first pass membranes by securing the permeate outlet without disrupting the feedwater and brine flow through the membrane.

3.19.13 Reverse Osmosis Element (Membrane)

The RO membrane element shall have a minimum stabilized salt rejection rate of 99.4 percent. The overall first pass membrane flux density with normal seawater feed (45,000 ppm of TDS) shall not exceed 12.5 gallons per square foot per day (gfd) at seawater temperatures up to 104 degrees F. The RO unit shall be designed to use membranes from three different manufactures. Second pass membranes shall be designed with a 0.95 membrane fouling factor or the equivalent. Second overall pass membrane flux shall not exceed 22 gallons per square foot per day (gfd).

3.19.14 Dumping System

A means shall be provided to automatically dump high TDS permeate to waste and to manually redirect permeate to freshwater storage tanks again, once satisfactory permeate quality has been restored. This component shall be equipped for indication at the ship’s remote control panel when the system is in the dump mode. Within 1 second of receiving a signal from the salinity monitoring system, the dumping component shall be capable of redirecting permeate from the freshwater tank line to the overboard line. The component shall be provided with a means of manually diverting permeate flow to the ships storage tank during emergency conditions. The system shall automatically dump the permeate to overboard upon a loss of power. The dumping system shall meet the test requirements in para. 4.5.17.

3.19.15 Low Pressure Relief Valves

Low-pressure relief valves shall meet the requirements of ASTM F1508 with Supplements S1 through S4. Rupture disks shall not be used as a means of preventing over-pressurization.

3.19.16 High Pressure Relief Valves

High-pressure relief valves shall meet the requirements of ASTM F1508 with Supplements S1 through S4. Rupture disks shall not be used as a means of preventing over-pressurization.

3.19.17 Flow Measurement

The instrument shall have an accuracy of ± 5 percent or better at full flow. Paddle-wheel flowmeters shall not be used.

3.19.18 Totalizing Flowmeter

The totalizing permeate flow measurement shall have a repeatability of ± 2 percent over the full range of flows at a constant temperature. The totalizing flow measurement shall measure the permeate flowing into the freshwater tanks.

3.19.19 Freshwater Flushing

The RO unit shall include provisions and a connection to freshwater flush the complete system using de-chlorinated shipboard freshwater. This freshwater flush shall be initiated by activating a remote distilled water transfer pump (pump is not supplied with the RO unit) via a contact rated for 110 VAC, 1 phase, 60 Hz, and aligning the unit for the freshwater flush. This freshwater flush shall be accomplished automatically whenever the RO unit is secured and at one week intervals. The fresh water flush procedure and lay-up shall be suitable for extended lay-up of the RO unit without the use of chemicals. RO unit lay-up with chemicals shall only be required when there is no source of freshwater. The RO unit control system shall indicate a summary fault alarm and open the remote pump run contact when the freshwater flush fails to complete due to lack of sufficient fresh water pressure. The freshwater flush duration shall be identified by the RO manufacture and sufficient to reduce the total dissolved solids level of the concentrate discharge from the first pass to below 800 ppm TDS.

3.19.20 Chemical Cleaning Equipment

Provisions shall be installed to permit chemical cleaning/disinfection’s of the first and second pass membranes independently. The desired cleaning method is to provide connections in the feedwater inlet, brine/concentrate, and permeate discharge for connection of a chemical cleaning circulation system. This chemical circulation system will circulate the cleaning/disinfectant chemicals through the membrane using a pump. This circulation system and pump does not have to be provided with the RO system as a special tool. The cleaning procedures and recommended materials must be detailed in the technical manual. Installation of a permanently mounted cleaning tank is not required.

3.19.21 High Pressure Pumps

The high pressure pump shall be a positive displacement design. The positive displacement pump shall be designed and tested in accordance with the American National Standard for Reciprocating Power Pumps.

3.19.22 Distributed Isolation Material (DIM)

If needed, the complete unit shall be sound isolated by "PAD TYPE" mountings of Distributed Isolation Material (DIM) or by resilient mounts (see para. 3.19.23). The DIM shall be selected on its demonstrated compatibility with the unit environment and shall be of the type manufactured by Fabreeka Products Co., Gilmore Industries Inc., Kohary Industries Inc., or equal in accordance with Mil. Spec. MIL-D-24709 dated 4 November 1988. In addition, the DIM shall be selected based on its ability to attenuate noise and

vibration in the desired frequency range and to avoid objectionable amplification outside that range. DIM shall be loaded to the degree required for proper isolation and shall be provided with means to prevent excess loading resulting from overtightening of mounting bolts as well as means to maintain the mounted item captive under shock. Mounting bolts shall have isolation bushings of material similar to the DIM to prevent metal-to-metal contact. Holes for mounting bolts shall be of sufficient diameter to provide clearance for the isolation bushings which is equal to twice the thickness of the isolation bushings. Guidance for selection, and installation of DIM mounts is provided in publication, NAVSEA S9078-AA-HBK-010/DIM.

3.19.23 Resilient Mounts

Resilient mounts for high pressure pump mounting or piping supports shall be selected and installed in accordance with publication, S9073-A2-HBK-010. Resilient elements shall not be painted except for temporary application of Spraylat, or equal. (For guidance regarding inadvertent painting of rubber elements and paint removal, see Section 2.5.2 of publication, NAVSEA S9073-A2-HBK-010). The resilient mounts shall only support the high pressure pump assembly and attached components (i.e. motor, belt guard, desurger, suction and discharge dogleg hose assemblies). The other RO system components shall be separately mounted, as required to meet the system shock, vibration, and noise requirements.

3.19.24 Permeate Treatment

The RO unit shall be provided with an ultraviolet sterilizer in the final permeate discharge to the ships potable water tanks. The sterilizer shall conform to ANSI/NSF 55-2002. Provisions shall be provided to secure power to the sterilizer under no flow conditions and indicate an alarm condition upon sterilizer failure.

3.20 Electrical Equipment

3.20.1 General

The RO unit shall operate with a separate 440 Vac, 60 Hz, three-phase, ungrounded delta power source for the high pressure pump. Electrical power for the control system or any other reduced voltage requirements shall be taken from the high pressure pump 440 Vac power source. All electrical cables outside electrical component enclosures shall be low-smoke cable per MIL-C-24643.

3.20.2 Motors

Electric motors shall meet the requirements of IEEE-45 and NEMA MG 1, and shall have the following characteristics:

a. NEMA Design B
b. Class F Insulation
c. 50 degrees C, ambient
d. Continuous duty
e. TEFC, severe duty
f. Airborne noise ≤ 80 dbA
g. Bearing temperature rise ≤ 40°C measured on the bearing outer ring
h. Provided with double sealed bearings

The horsepower (hp) rating of each motor shall be in accordance with the motor ratings, but not less than 1.05 times the brake horsepower of the driven pump under rated conditions of capacity and pressure.

3.20.3 Control System Components

The motor controls, control logic devices, Programmable Logic Controllers (PLC), switches, and HMI system shall meet the requirements of Mil. Spec. MIL-DTL-2212H dated 10 February 1997. The HMI and control system shall provide both visual and audible alarms. The HMI shall only indicate the first alarm or fault until the alarm is acknowledged. Manually operated switches, controllers, master switches, and relays shall also meet the requirements of Mil. Spec. MIL-DTL-2212H dated 10 February 1997. A terminal board shall be provided for connection of the remote indications and control inputs identified in para. 3.5. Commercial-Off-The-Shelf (COTS) components maybe used provided provisions are taken to meet the qualification requirement contained in this statement of work document. These components shall meet the requirements of IEEE 45 and NEMA ICS 1, ICS 2, ICS 3.1 and ICS 4 as applicable. The controller for a positive displacement type high pressure pump shall incorporate a reduced voltage or soft start control system. This system shall meet the interface requirements specified in MIL-STD-1399, Section 300A, Notice 1 dated 11 March 1992. The soft starter shall not require a cool down period prior to initiating or reinitiating a normal stop or restart. The soft start shall be capable of restarting the motor at any time, including immediately following shutdown. There shall be no limit on the number of consecutive starts. This system shall also meet the interface requirements specified in MIL-STD-1399, Section 300A with Notice 1 dated 11 March 1992 including power quality requirements. Use of a line to line EMI filter is considered acceptable to meet the EMI requirements specified in section 3.10. EMI filter line to ground capacitance shall be in accordance with MIL-STD 1399, Section 300A with Notice 1 dated 11 March 1992.

3.20.3.1 Control Panel

The control panel and its components shall meet the requirements of Mil. Spec. MIL-DTL-2212H dated 10 February 1997. Commercial-Off-The-Shelf (COTS) components maybe used provided provisions are taken to meet the qualification requirement contained in this statement of work document. These components shall meet the requirements of IEEE 45 and NEMA ICS 1, ICS 2, ICS 3.1 and ICS 4 as applicable. The control panel shall be prewired to the maximum extent possible and contain the devices necessary to operate the RO unit.

3.20.3.2 Enclosures

All electrical enclosures shall be totally enclosed, drip proof (15 degrees protected) in accordance with Mil. Spec. MIL-E-2036D dated 10 March 1988. Enclosures for commercial components requiring fan cooling shall be spray tight as defined by NEMA 250.

3.20.3.3 Logic Controller

A PLC shall be provided to automatically control the RO unit. A means for overriding and manually operating the system shall be provided. The PLC and HMI program shall be maintained in EPROM memory device for each component that will allow the component to be replaced and re-booted with the required operating program without the need to accomplish any programming steps.

3.20.3.4 Dielectric Strength

Insulation between any pair of mutually insulated electrical circuits or between any electrical terminal and the unit’s frame/base shall withstand the following conditions:

a. Insulation resistance not less than 10 megohms with 500 plus 50 Vdc applied.

b. 60 Hz dielectric voltage of 1,500 volts rms or twice the rated voltage plus 1,000 volts rms, whichever is greater, for one minute without any arcing, sparking, or current leakage in excess of 10 millamperes.

3.20.3.5 Insulation Resistance

The insulation resistance of all electrical components shall have a minimum value of 10 megohms at 25 degrees C.

3.20.3.6 Mechanical Indexing

Mating lines, cables, and connections shall have mechanical indexing features to prevent improper connection. Wiring markings and indexing shall correspond to the manufacturer's applicable diagrams.

3.20.3.7 Grounding

Grounding of equipment shall meet the requirements of MIL-STD-1310G dated 28 June 1996.

3.20.4 Conductivity System

Salinity indicating and controlling equipment shall meet the conformance test requirements (see para. 4.5.16).

3.20.5 Elapsed-Time Meter

This item shall be provided to measure total hours of HP pump operation. No manual reset feature is permitted.

3.21 Technical Manuals

Enclosed with each delivered RO Unit shall be technical manuals and operational documentation with any addenda or attachments necessary to meet the requirements of sections 3.21.1 through 3.21.8. Two bound hard copies and two electronic copies of the technical manuals and operational documentation shall be provided for the RO system.

3.21.1 General. The manual shall precisely reflect the configuration of the RO Unit. The manual shall consist of all data (volumes, folders, inserts, specification sheets, and other documents) required for the operation and maintenance of the RO System.

3.21.2 Safety. The manual shall contain appropriate warnings, cautions, and notes.

3.21.3 Illustrations. The manual shall contain illustrations to support the text. Illustrations shall be suitable for locating and identifying all components. Illustrations shall be prescreened, sharp, and with good contrast. Illustrations shall be line drawings or photographs. Line drawings are preferred over photographs. Illustrations shall not be free hand sketches.

3.21.4 Preparation for use. The manual shall contain instructions for unpacking, assembling, and readying for operation.

3.21.5 Operation. Operating instructions shall include the principles of operation; illustrations and explanation of the uses and functions of all controls and indicators; initial set up; initial settings; and start up, normal operation, calibration, shutdown, and emergency shut down procedures.

3.21.6 Maintenance. The manual shall include the manufacturer's maintenance required for the RO Unit and shall be delineated such that it can be applied by the intended Government user. The manual shall include planned and corrective maintenance and overhaul procedures with lists of required test equipment, special tools and materials. Procedures to recognize and deal with sensor saturation shall be included. The nomenclature, part/model number and materials shall be included. Diagnostic tests and tests to ensure satisfactory performance shall be detailed.

3.21.7 Troubleshooting. The manual shall include troubleshooting procedures for all possible failure modes. The procedures shall include a description of the trouble, a possible cause, and a remedy. The Remedy shall either provide the corrective action or refer the user to the section in the manual, which provides the corrective action.

3.21.8 Parts list, illustrations and diagrams. The manual shall include a parts list, which identifies all parts of the system. The parts list shall include the actual manufacturer or vendor name, the part number, and a generic description necessary to obtain replacement parts. Clear and legible illustrations shall identify all component parts and parts relationships. Electrical point to point wiring diagrams with wire numbers shall be provided. System diagrams shall be included as necessary.

3.22 Provisioning Data

Provisioning data shall be provided for the first production RO system in the contractor's format. All lines, symbols, letters and numerals shall be readable and in accordance with industry standard.

3.22.1 Provisioning Technical Documentation

The provisioning documentation shall include all user replaceable parts and shall include a breakdown of the unit's assemblies and sub-assemblies down to the individual replaceable parts.

3.22.2 Provisioning parts list

The provisioning parts list shall include piece part information on all user replaceable parts. CAGE and part number information shall be for the actual manufacturer of the complete finished part as used in the RO System. Data required for each item as follows:

a. Manufacturer's CAGE
b. Manufacturer's Part Number
c. Nomenclature
d. Unit Price
e. Remarks (mandatory change-out or other part information)

3.22.3 Supplementary provisioning technical documentation

Supplementary provisioning technical documentation shall be provided for each item on the provisioning parts list. Supplementary provisioning technical documentation is technical data used to describe parts of equipment. It consists of specifications, standards, drawings, photographs, sketches, descriptions, assembly and arrangement drawings, schematic diagrams, wiring and cabling diagrams needed to indicate the physical characteristic, actions and function of the item. Supplementary provisioning technical documentation shall be provided in the following order of precedence:

a. Government or recognized industry specifications or standards (identification only, copies are not required).

b. Commercial drawings.

c. Commercial catalogs or catalog description.

d. Sketches or photographs with brief descriptions of dimensional, material, mechanical, electrical, or other descriptive characteristics. When sketches or photographs are provided for an assembly, a parts list shall also be provided.

3.23 Drawings

Drawings shall be prepared in accordance with ASME Y14.1, Y14.2M, Y14.3M, and Y14.5M and all text written in the English language. All drawings shall be completely legible and suitable for microfilming/reproduction.

3.23.1 Types of Drawings

The following types of drawings shall be prepared.

3.23.1.1 Outline Drawing

An external arrangement drawing shall be prepared that shows all necessary external views of the RO unit and shall include the center of gravity, weight (dry and operating), and all external dimensions required for reproduction of ship's machinery arrangement drawings. These drawings shall provide guidance to the shipyard in designing the foundation structure for installing the unit. It shall show connection of the unit to the external piping including chemical cleaning, vents, and drains. The drawing shall show the space required for removing and replacing membranes and filter elements. All lifting lugs or eyebolts and their dimensional openings shall be shown on the drawing.

3.23.1.2 Assembly Drawing

A drawing showing completed longitudinal and transverse cross-sectional views of the RO unit shall be prepared that depicts the relationship of all parts, components, and arrangement of membranes in their housings. The Top Assembly drawing shall identify by correspondence number and date, the acceptance for Navy shock, vibration, and EMI testing, where applicable. Liberal use of enlarged views or sections shall be made. Subassembly drawings conforming to the above shall be furnished to aid in the clarity of individual components. The drawings shall be such that a thorough understanding of the design material selection and construction of the apparatus may be obtained without reference to related detailed drawings.

3.23.1.2.1 List of Materials

The assembly drawing shall contain a list of materials showing the names of parts with identifying numbers and materials of all parts. The identifying numbers shall also be shown adjacent to the part shown in the various views, with arrows pointing to the parts. Each item shall be easily located with a find number in a minimum of two views.

3.23.1.3 Detailed Drawings

Component arrangement and sectional drawings shall contain sufficient information that discloses a design approach suitable to support the manufacture of a production prototype and lists all of the component parts and material specifications. The drawings shall be completely dimensioned, with finishes and welding symbols indicated as required for manufacture.

3.23.1.4 Diagrammatic Drawings

The diagrammatic piping arrangement drawing (Process and Instrumentation and Flow diagrams) shall show the complete piping required for operating the RO unit. Piping furnished with the unit and piping furnished by the Contractor shall be clearly indicated. Location of gages, thermometers, valves, orifice plates, chemical cleaning connections, and salinity indicators shall be indicated. The drawing shall also indicate pipe size, orifice size, flow rates, flow directions, relief valve setpoints, pressure at the various points, shipyard maximum back-pressure requirements, minimum supply pressure, and all operating parameters at terminal points. The actual location of each instrument connection and component shall be the same as that on the assembly drawings. The symbols used shall be in accordance with ASTM F1000.

3.23.1.5 Wiring Drawings

Wiring assembly drawings showing terminal connections shall be provided for all electrical components furnished with the RO unit.

3.23.1.5.1 Electrical Drawings

The electrical drawings shall consist of separate schematic (elementary) and connection (point-to-point wiring) diagrams to clarify the control functions and simplify the wiring.

3.23.1.5.2 Legends

Standard legends and symbols specified in ANSI 315A shall be used on all electrical drawings.

3.23.1.6 Data

The following data shall be prepared:

a. Range of velocities of seawater, brine, and freshwater in various portions of the system over the range of operating conditions.

b. Desalination plant capacity curves shall be prepared for the following temperatures and salinity's: 40 degrees F, 60 degrees F, 75 degrees F, 77 degrees F, 95 degrees F, and 104 degrees F at 35,000 ppm TDS, 40,000 ppm TDS and 45,000 ppm TDS.

c. Hydrostatic test pressure for the low and high pressure sub-systems and all similar pertinent design data.

d. A drawing list tabulation with columns for drawing title, manufacturer's drawing number, and revision symbol. This list shall include all equipment drawings that constitute the design. The revision symbol column shall be kept up to date to the time of manufacture so that it will indicate for each drawing the revision applicable to the equipment as built.

e. List of recommended onboard repair parts and quantities recommended.

f. Any prior approved procuring activity deviations.

g. Vibration, EMI, and electric interface testing.

h. Certificates of Compliance for materials used in critical components such as HP pump, relief valves, flow meters, high pressure piping, valves and fittings, pulsation dampener, and pressure vessels.

3.23.1.7 Purpose of Drawings

Sufficient drawings shall be prepared to:

a. Provide design information to ensure conformance to requirements of this specification, including compatibility with ship and ship systems.

b. Evaluate performance and maintenance capability.

c. Enable shipyard installation without contractor's assistance.

d. Enable naval ship and shore activities to repair and maintain the item without assistance from the original contractor.

3.23.1.8 Final Drawings

Final submitted drawings and associated lists shall be to the level that provides engineering definition sufficiently complete to support the purposes listed above without resorting to additional product design effort, additional design data, or recourse to the original design activity, and the specific requirements in this specification. As-built dimensional drawings shall be submitted with each unit.

3.24 Reliability Definitions

3.24.1 Corrective Maintenance

All actions performed as a result of failure, to restore an item to a specified condition. Corrective maintenance can include any or all of the

following steps: Localization, Isolation, Disassembly, Interchange, Reassembly, Alignment, and Checkout.

3.24.2 Preventative Maintenance

All actions performed in an attempt to retain an item in specified condition by providing systematic inspection, detection, and prevention of incipient failures.

3.24.3 Mean-Time-Between-Failure (MTBF)

A basic measure of reliability for repairable items: The mean number of life units during which all parts of the item perform within their specified limits thereby permitting the unit to meet mission function, during a particular measurement interval under stated conditions.

3.24.4 Operational availability (A_o)

A measure of the degree to which an item is in an operable and committable state at the start of a mission when the mission is called for at an unknown (random) time.

3.24.5 Unit Design Life

The number of design life units from manufacture to when the item has an unrepairable failure or unacceptable failure rate.

3.24.6 Mean-Time-To-Repair (MTTR)

A basic measure of maintainability: The sum of corrective maintenance times for any specific repair, divided by the total number of failures within an item for that specific repair, during a particular interval under stated conditions.

3.24.7 Maximum Time To Repair (Mmaxct)

The maximum time to perform corrective maintenance for any specific repair.

3.24.8 Mean Preventative Maintenance Time (Mpt)

The sum of preventative maintenance times for any specific maintenance item, divided by the total number of preventative maintenance items for that specific item, during a particular interval under stated conditions.

3.24.9 Maximum Preventative Maintenance Time (Mmaxpt)

The maximum time to perform preventative maintenance for any specific maintenance item.

3.24.10 Mean Maintenance Time

The measure of item maintainability taking into account maintenance policy. The sum of preventative and corrective maintenance times, divided by the sum of scheduled and unscheduled maintenance events, during a stated period of time.

4.0 QUALITY ASSURANCE PROVISION

4.1 Responsibility for Inspection

Unless otherwise specified in the contract, the Contractor is responsible for the performance of all inspection requirements specified herein. Except as otherwise specified in the contract, the Contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein. NSWC reserves the right to perform any of the inspections set forth in the contract where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements. Any inspections performed by NSWC shall not relieve the Contractor of its

responsibility for quality assurance and for providing RO units, which conform to the contract requirements.

4.1.1 Quality Program Requirements

The Contractor shall provide and maintain a quality system that, as a minimum, adheres to the requirements of either Mil. Spec. MIL-I-45208A dated 20 September 1995 or ANSI/ISO/ASQC Q9001-1994 or ANSI/ISO/ASQC Q9002-1994 and supplemental requirements imposed by the resultant contract. Conformance with these requirements shall not be construed as relieving the Contractor of final responsibility to furnish equipment and services meeting specification requirements. Utilization of a material review board requires the written approval of NSWC.

4.2 Classifications of Inspections

The inspection requirements specified herein are classified as follows:

a. First article inspection (see para. 4.3).
b. Conformance inspection (see para. 4.4).

4.3 First Article Inspection

First article inspection shall consist of examinations and tests specified in Table III. For designs not previously approved for U.S. Navy shipboard use, a design review meeting shall be held prior to initial manufacturing of the unit to evaluate the design and review the calculations and analysis for the RO unit. This design review meeting does not absolve the manufacturer of responsibility for meeting the requirements of this specification. Unless the Navy has previously qualified the unit being offered for production, a 45-day (2160-hour) qualification test shall be conducted on full density natural seawater to demonstrate the unit’s ability to meet the requirements for performance, reliability, and endurance. A procedure for this test shall be submitted to NSWC for review and approval 20 days prior to commencement of the test.

4.4 Conformance Inspection

Conformance inspection shall be performed on all RO units prior to delivery and shall consist of applicable examinations and tests specified in Table IV.

4.5 Examination Tests

The RO unit shall be examined and tested for compliance with the requirements specified in Section 3. Any necessary redesign or modification following failure to meet the specified requirements shall receive particular attention for adequacy and suitability. This element of inspection shall encompass all visual examinations and dimensional measurements. Where possible, pressure boundary welds for both freshwater and seawater service shall be examined to verify that the welds are free of crevices, notches, porosity and pockets. Noncompliance with any specified requirements or presence of one or more defects preventing or lessening maximum efficiency shall constitute cause for rejection. The RO unit shall be checked (by the procuring activity representative) with respect to material, finish, construction, assembly, dimensions, weight, and marking of identification and description plates. For conformance inspections (see para. 4.4), this examination shall be limited to those inspections that can be performed without disassembling the unit in such a manner that its performance, durability, or appearance would be affected. The completed RO unit shall be examined to ensure that the required controls, indicators, valves, electrical equipment and other components are installed. Parallel or combined testing is permitted, provided the intent of any test is not compromised.

4.5.1 45 Day Qualification Testing

For new RO system designs and vendor first-article testing, a 45-day test on natural seawater is required (see para. 4.3). Test shall be conducted by a NSWC approved independent, certified test facility. For this test, a single 1,200 GPD RO unit shall be operated continuously (or as nearly so as practical) for 45 days using natural, full-density seawater of 32,000 ppm ± 4000 ppm TDS with a 15 minute SDI of at least 6.0. A closed loop test facility is prohibited for this test. A means shall be provided for operating the RO unit at feedwater temperatures between 75 to 104 degrees F and 45,000 ppm ± 2000 ppm TDS to demonstrate its ability to meet the capacity and salinity required in para. 3.3. This operating range test shall be accomplished at the beginning of the 45 day test and at the end. A portion of the brine and permeate maybe re-circulated for this portion of the test. Performance shall be within the requirements listed in para. 3.3. Additionally, at least one hour of testing shall be conducted at 60 degrees F, plus or minus 3 degrees F, seawater feed temperatures. It shall be demonstrated that the capacity over the specified period of operation is not less than the specified rated capacity at minimum inlet temperature and conditions specified in para. 3.3.1.1. Operational requirements of para. 3.4 and membrane flux density (see para. 3.19.13) shall be demonstrated. There shall be no more than a 15 percent reduction in normalized production rate between the start and completion of the test. Normalization shall be determined in accordance with ASTM D4516 to standard conditions. Standard permeate pressure shall be assumed to be 15 psig. Permeate water quality shall meet the requirements of para. 3.3.4 at all times during the test, based on 45,000 ppm feed water (see para. 4.5.3). There shall be no more than a 15 percent increase in permeate salinity (ppm TDS) over the course of this test. Membrane data and analysis shall be utilized to verify the capability of the unit to meet production under the fouled condition. The accuracy of the salinity monitoring system shall be demonstrated during this test.

4.5.1.1 Pre-test

Prior to the start of the qualification test, all safety and mechanical systems and devices shall be verified to be in proper working order. All components, instruments, monitoring, controls, and flow measurement devices shall be functional and calibrated.

4.5.1.2 Data Recording

Prior to the start of the 45 day test and again at the completion of the test, dimensions shall be measured and recorded for key wearing components in the pumps. Similarly, an internal visual examination shall be made of the brine throttling device before and after the test. Initial readings shall also be recorded for pressures, temperatures, flows, feedwater pH, salinity (seawater feed, brine, and permeate) and pump leakage rate. The manufacturer is encouraged to recommend other readings that shall be monitored. Unit shutdowns shall only be permitted for routine maintenance such as changing pump oil. The time required for performing all maintenance and repairs during this test shall be recorded. The test shall be extended to make up for the downtime for repairs until the full 45 day first article test has been completed. In the event repair and maintenance times exceed the limitations specified in para. 3.7, the test will be considered unsuccessful. At set intervals during the test, the SDI values for the seawater feed and the water exiting the filters shall be measured to demonstrate that the filters provide filtrate having a 15 minute SDI of 5.0 or less for the duration of the test.

4.5.1.3 Post-test Examination and Report

A post test examination shall be performed to determine if any internal corrosion (see para. 3.16), damage or paint deterioration (see para. 4.6) has occurred that would prove detrimental to the specified (see para. 3.3.5)

service life of the RO unit. Seawater pipes (including hoses) and boundaries that can be disassembled shall be opened and examined for corrosion (degradation) and pitting (see para. 3.16). Representative sections of flanged high and low pressure piping, system valves membrane pressure vessels, and pretreatment system pressure vessels shall be inspected. Record these results, along with the results of the pump and throttling device inspections specified in para. 4.5.1.2.

TABLE III.- FIRST ARTICLE INSPECTION

FIRST ARTICLE EXAMINATION OR TEST	REQUIREMENT	EXAMINATION/ TEST	PROCEDURES
Design review	1.4, 3.0	4.3	
Characteristics			
Envelope size, (including maintenance access)	3.1	4.5	
Terminal locations	3.1.1	4.5	
System requirements	3.1.2	4.5	
Controls and indicators	3.5	4.5	4.5.1.1
Salinity indicating system	3.5.2	4.5	4.5.16/17
Interchangeability	3.9	4.5	
Identification plates	3.15, 3.20.3.6	4.5	
Materials	3.16	4.5	4.5.1.2
Fabrication	3.17	4.5.11, 4.5.12	4.5.11
Frames and bedplates	3.17.4	4.5	
Paint	3.17.6	4.5, 4.6	
Safety	3.18	4.5	
Components	3.19	4.5	
Electrical equipment	3.20	4.5	4.5.1.1
Performance			
45 day qualification	3.2.1, 3.16	4.5.1	4.5.1
Permeate production rate	3.3.1.1	4.5.1	
Permeate water quality	3.3.4	4.5.3	
Operation			
Normal operation	3.4.1	4.5.1	
Monitoring	3.4.2	4.5.16, 4.5.17	
Start-up/shutdown	3.4.3	4.5.1	
Cleaning	3.4.4	4.5	
Energy consumption	3.4.5	4.5.2	
Electric controls	3.5, 3.20.3	4.5	4.5.1.1
Preventative maintenance and repair	3.6	4.5.9	4.5.9
Reliability	3.7	4.5.10	
Hydrostatic pressure	3.8	4.5.5	4.5.5
Electromagnetic interference	3.10	4.5.15	4.5.15
Vibration	3.12	4.5.7	4.5.7
Ship attitude or motion	3.13	4.5	
Components			
Filters	3.19.6	4.5.1.3	4.5.1
Flow measurement	3.19.17, 3.19.18	4.5.1.3	
Electrical equipment			
Dielectric strength	3.20.3.4	4.5.13	4.5.13
Insulation resistance	3.20.3.5	4.5.14	4.5.14
Electric power system interface	3.20.3	4.5.18	4.5.18

TABLE IV.- CONFORMANCE INSPECTION

EXAMINATION OR TEST	REQUIREMENT	QUALITY CONFORMANCE TEST	PROCEDURES
Characteristics			
Terminal points	3.1.1	4.5	
Identification plates	3.15, 3.20.3.6	4.5	
Safety	3.18	4.5	
Components	3.19	4.5	
Performance			
8-hour performance	3.2.2	4.5.4	4.5.4
Permeate flow rate indication	3.3.1.1	4.5.4	
Salinity indicating System	3.5.2	4.5.16,4.5.17	4.5.4 4.5.17.2
Hydrostatic test	3.8	4.5.5	4.5.5
Electrical equipment			
Dielectric strength	3.20.3.4	4.5.13	4.5.13
Insulation resistance	3.20.3.5	4.5.14	4.5.14

4.5.1.4 Post Test

At the conclusion of the qualification testing (see para. 4.5.1), flush the unit with freshwater, remove the RO membrane test elements and filter media, drain and dry the RO unit. A new set of RO membrane elements still in their original packing shall be shipped with the unit. These shall not be installed until the RO unit is ready for operation. The test RO membrane elements may be reused for subsequent testing of other units if they are properly preserved and stored between tests.

4.5.1.5 Acceptance Criteria

To pass the 45-day operational test, no major component shall cause the RO unit to fail to provide acceptable permeate at any time during the testing (see paras. 3.3.4 and 4.5.1). There shall be no indications of general corrosion that results in a wall loss greater than 1 mil internal to the unit. Localized crevice corrosion over 2 mils wide and pits in excess of 15 mils deep will also constitute failure. External surface oxidation or rust of painted components or unit frame shall not exceed 1 square inch per any square foot area of the assembly. For the purpose of this test, major components are defined as:

a. Centrifugal separator (if used)
b. Filters and housings
c. High pressure pump and motor
d. RO membranes and pressure vessels
f. Brine throttling device
g. Flowmeters
h. Accumulator/pulsation dampener
i. Salinity monitoring and dumping system
j. Strainer
k. Controls

4.5.2 Energy Consumption

The RO unit shall be tested to determine maximum power required for operation (see para. 3.4.5). Maximum power is defined to include all electric components operating at maximum load.

4.5.3 Permeate Water Quality

The permeate water quality shall meet the requirements specified in para. 3.3.4 when operating with full-density natural seawater. The salinity content

shall be tested using the salinity indicating equipment installed on the unit. For first article inspection, the salinity content shall be verified, both at the beginning and at the end of the tests, by an independent, certified laboratory. The test for chloride ions shall be in accordance with ASTM D512.

4.5.4 8-hour Operational Test

An operational test shall be conducted on each production RO unit offered for delivery. Prior to the start of the qualification test, all safety and mechanical systems and devices shall be verified to be in proper working order. All components, instruments, monitoring, controls, and flow measurement devices shall be functional and calibrated. Each unit shall be operated for 8-hours continuously with membrane simulators installed that are sized to allow the unit to operate at the maximum design operating pressures. The salinity content of feedwater shall not exceed that specified in para. 3.3.4 for the final permeate. All components and controls shall be functional during the entire test. The accuracy of the salinity monitoring system shall be demonstrated during this test.

4.5.4.1 Post Test

After the 8-hour test, flush the unit with freshwater, remove the RO membrane simulators and cartridge filters, drain and dry the RO unit. A new set of RO membrane elements and pre-filter media, still in their original packing, shall be shipped with the unit. The membranes will not be installed until the RO unit is ready for operation.

4.5.4.2 Acceptance Criteria

The acceptance criteria for the 8-hour operational test shall be that no major component causes the RO unit to fail to provide acceptable permeate at required capacity during the 8-hour run (see para. 3.3.4). Major components are the same as those listed in para. 4.5.1.5. Minor components such as pressure and temperature gages and switches, valves, relief valves, and hoses may be repaired during this test. The test shall then be extended to make up for the downtime for repairs until the full 8-hour operation has been successfully completed.

4.5.5 Hydrostatic Pressure

The RO unit, except membranes and filter elements, shall be subjected to a hydrostatic pressure test of 1-1/2 times the design pressure (50 psig minimum). Test pressure shall be successfully held for 30 minutes before visual inspection. There shall be zero leakage in all areas except at the pump packing, where applicable.

4.5.6 Not Used

4.5.7 Vibration

The assembled RO system shall meet the vibration requirements specified in 3.12 and shall be tested in accordance with MIL-STD-167/1 dated 19 June 1987. More than three interruptions during the endurance portion of the test, in any one axis, will require retesting after the problem has been resolved. The RO unit shall be operational during testing using synthetic, full-density feedwater at rated capacity. After the vibration test, a 4-hour performance test shall be performed. Reciprocating type high pressure pumps (if used) shall also be analyzed and tested for Type III torsional vibration in accordance with MIL-STD-167/2.

4.5.8 Not Used

4.5.9 Maintainability

The RO system shall meet the requirements for maintenance and repair as specified in para. 3.6. The manufacturer shall demonstrate, as part of the

first article testing, the maintenance procedures and removal of parts from the unit for repair and the time required for accomplishment.

4.5.10 Reliability

The RO system shall meet the requirements of para. 3.7.

4.5.11 Data Collection, Analysis and Corrective Action

R&M Data Collection, Analysis and Corrective Action (DCACA) program shall be performed. The R&M DCACA program includes the Failure Reporting, Analysis and Corrective Action System (FRACAS) in accordance with MIL-STD-785B dated 3 July 1986, Task 104 and the DCACA program in accordance with MIL-STD-470A dated 26 August 1987, Task 104. The R&M DCACA Program applies to all equipment procured by this statement of work document. The DCACA program shall commence when an equipment undergoes any test activity and shall continue through final RO unit acceptance. The R&M DCACA program shall include:

a. Documentation of all malfunctions according to the following definition: Malfunction event - an event in which an item does not perform its intended function, regardless of impact on equipment or system performance or the method and duration of restoration.

b. Analysis of each malfunction or technical problem with emphasis on pattern malfunctions to include identification of repaired, replaced or adjusted item, circumstances surrounding the malfunction, malfunction symptoms, and probable cause of malfunction.

c. Classification of malfunction events as failures or non-failures according to the following definitions: **Failure** - any malfunction or combination of malfunctions that prevents an equipment or system from operating in one or more modes of operation in accordance with the performance requirements. **Non-failure** - any malfunction or combination of malfunctions that is not classified as a failure shall be classified as a non-failure.

d. Classification of failure based on its relevancy. Relevant and non-relevant failure definitions shall be as specified in MIL-STD-781D dated 17 October 1986, paragraph 4.7, modified as follows:

(1) Add the following typical relevant failures to para. 4.7.1:
Design defects
Manufacturing defects
Parts defects
Unknown
All other categories not specifically listed as non-relevant

(2) Add the following typical nonrelevant failures to para. 4.7.2:
Accidents, mishandling, or improper storage after installation check-out.
Operator or procedural error (provided documentation errors are promptly corrected and verified by the Supplier).
Installation or maintenance errors due to drawing error implementation (provided documentation errors are promptly corrected and verified by the Supplier).

(3) In addition to the above classification criteria, the following requirements apply to para. 4.7.1:
Failure due to wrong or missing parts is relevant unless clearly in a non-relevant definition.
A transient failure, which is non-repetitive and does not require repair, is non-relevant. The second such failure and any additional failures of this type shall be considered relevant.

Failure of a serial or redundant item, as the direct result of failure of another serial item, is non-relevant. However, a failure of a redundant item that causes failure of a series item or the entire redundant function shall be considered a relevant failure. Failures are not multiple unless they are independent.

e. Statement for each malfunction of the immediate corrective action and recommendation, if different, for permanent corrective action.

f. Verification that corrective action has been implemented in applicable source control drawings, maintenance manuals, and other technical data.

g. Analysis of maintainability problems to determine required corrective actions, such as, equipment design change to improve accessibility, repair time, frequency of failure, or documentation.

h. The Contractor shall participate in a Buyer's failure review board.

i. Failure Summary reports and DCACA Reports shall be prepared.

4.5.12 Welding Inspection

All stages of welding and brazing shall be subject to full-time inspection by the procuring activity representative to ensure manufacturer compliance with the requirements of publication, NAVSEA S9074-AR-GIB-010/278 and ASME Section IX. Such inspection shall not relieve manufacturer of his responsibility to provide quality materials and workmanship. Butt-welded pressure boundaries with design pressure over 300 psig shall receive radiograph inspection in accordance with publication, NAVSEA S9074-AR-GIB-010/278. All welded seam high pressure seawater or brine piping shall be 100 percent Radiographic Test (RT) inspected and approved in accordance with publication, NAVSEA T9074-AS-GIB-010/271. Repairs to any pressure boundary shall be in accordance with publication, NAVSEA S9074-AR-GIB-010/278 and shall be accomplished following purchaser approval. Subsequent non-destructive testing (NDT) shall be to publication, NAVSEA T9074-AS-GIB-010/271 requirements.

4.5.13 Dielectric Strength

The RO unit shall be tested to verify that the dielectric strength requirements of para. 3.20.3.4 have been satisfied.

4.5.14 Insulation Resistance

The RO unit shall be tested to verify that the insulation resistance requirements of para. 3.20.3.5 have been satisfied.

4.5.15 Electromagnetic Interference (EMI)

The first article RO unit shall be tested to verify the unit meets the EMI emission and susceptibility requirements of MIL-STD-461E dated 20 August 1999 for surface ship equipment mounted below deck.

4.5.16 Salinity Indicating System

The following tests are required on the first article RO unit to determine whether the accuracy of para. 3.5.2.9 is met. Conductivity indicating systems previously qualified in accordance with Mil. Spec. MIL-S-15103 for shipboard use do not require testing.

4.5.16.1 Salinity Monitor

Simulated input to the sensor terminals of the salinity monitor shall be provided (either by decade boxes or some other means). The salinity meter shall be used to monitor the channel being tested. Salinity remote alarm and remote readout shall be monitored. Dump valve or the equivalent electrical load shall be connected to dump output terminals. Salinity monitor calibration shall be performed by inputting the appropriate resistance values. All of the data points shall be inputted to each salinity channel to verify that the

accuracy of the salinity monitor is as specified in para. 3.5.2.9. In addition, nine data points [three conductivity levels (10, 25, 100 or 250, 100, 2000 micromhos/cm) at three temperatures (40, 90, 105 degrees F) for each shall be inputted to each of the remaining salinity channels to verify salinity monitor accuracy. Accuracy of salinity alarm and remote alarm and dump alarm for each salinity channel shall be verified to be as specified in para. 3.5.2.9 by simulating a fixed temperature and slowly increasing the simulated conductivity until alarm actuation occurs.

4.5.16.2 Sensor Constant

The sensor constant shall be verified using the procedure specified in Method A of ASTM D1125.

4.5.16.2.1 Sensor Temperature Compensator Response

In order to determine the response of the temperature compensator to changes in fluid temperature, three distilled water baths shall be set up at the following temperatures 75 degrees F ± 5 degrees F, 125 degrees F ± 5 degrees F, 175 degrees F ± 5 degrees F. The baths shall be of sufficient volume that the temperatures will not be significantly affected by the immersion of the sensors as specified hereinafter. The temperature compensator leads shall be connected to an ohmmeter. The sensor shall be immersed in the 75 degrees F bath for at least 5 minutes and a resistance shall be taken. The sensor shall then be quickly transferred (in approximately 1 second) to the 125 degrees F bath. Using a stopwatch, resistance readings shall be taken every 10 seconds for approximately 1 minute or until readings begin to stabilize and thereafter readings shall be taken every 30 seconds until readings are completely stabilized. The above mentioned procedure shall be repeated with the sensor being transferred from the 125 degrees F bath to the 175 degrees F bath, from the 175 degrees F bath to the 125 degrees F bath, and from the 125 degrees F bath to the 75 degrees F bath. Response of the sensor temperature compensator resistance to step changes in temperature shall be as specified in para. 3.5.2.10.

4.5.16.3 System Accuracy (using test solution)

In order to determine system accuracy, sensors (having passed the sensor constant test of para. 4.5.15.2 and the sensor temperature compensator test of para. 4.5.15.2.1) shall be connected to a salinity monitor (which has passed the salinity monitor accuracy test of para. 4.5.15.1). Remote alarms, remote readouts, and dump shall be monitored as specified in para. 4.5.15.1. Sensor and valve assemblies shall be installed. Solution temperature, solution concentration and pressure shall be monitored by reference instruments throughout the testing. System accuracy of salinity monitor readouts and alarms shall be as specified in para. 3.5.2.9. Data tables shall include a tabulation of reference instruments, local and remote salinity meters, limits of error, and alarm actuation points. In the first sequence, solution temperature shall be maintained at 77 degrees F ± 1 degrees F for the duration of the test sequence while the solution concentration is increased in steps. Test points shall cover the full meter range. At least two of the test points shall be alarm actuation points. Each test point value shall be maintained for at least 5 minutes. At each test point, comparative readings shall be taken for all channels of local and remote salinity meters, as well as the reference instruments. In addition, alarms and dump shall be observed for correct actuation. In the second sequence, the solution concentration shall be maintained at a value within the range of the particular salinity meter. While holding the concentration constant, the temperature of the solution shall be varied over the following points: 40 degrees F, 77 degrees F, 100 degrees F, 150 degrees F, and 200 degrees F. The tolerance for each temperature shall be plus or minus 1 degrees F. Each test point shall be maintained for at least 5 minutes. At each test point, comparative readings shall be taken for all

channels on local and remote salinity meters, as well as the reference instruments.

4.5.16.4 Overrange (sensor short circuit)

The salinity indicating equipment shall be set up as specified in 4.5.15.3, except that the sensor shall not be immersed in a bath. A short circuit shall be applied across the electrode of each sensor, one at a time, for 5 minutes each. Following the application of short circuits, the equipment shall be subjected to the system accuracy test specified in para. 4.5.15.3. Performance of the salinity monitor shall be as specified in paras. 3.5.2.9 and 3.5.2.11.

4.5.17 Dumping System

The dumping system shall be tested for cyclic operation and watertightness in accordance with paras. 4.5.17.1 and 4.5.17.2.

4.5.17.1 Cyclic Test

The dumping component shall be installed in a line supplied with freshwater at a minimum of 50 psig at 60-90 degrees F and the solenoid shall be connected to the appropriate source of electrical power. The component shall be subjected to freshwater flow for 1000 cycles of operation. During this period of operation the component shall remain watertight in both of its operating positions. A test for watertightness in accordance with para. 4.5.17.2 shall be conducted at intervals of approximately 200 cycles and at the completion of the cyclic test.

4.5.17.2 Watertightness

The component shall be subjected to a hydrostatic pressure of 100 psig to test for strength and porosity. The component shall be subjected to the leak tests that follow. Test duration shall be 30 minutes at each test condition. The component shall be vented prior to each test to ensure that no air is present. The acceptance criteria for each test shall be that no leakage be observed from the appropriate port for the duration of each test:

a. The component in the latched position, inlet port pressurized to 50 psig, and the dump port at 0 psig.
b. The component in the dump position, inlet port pressurized to 50 psig, and the outlet port at 0 psig.
c. The component in the latched position, dump port pressurized to 15 psig, and the inlet port at 0 psig.

4.5.18 Electric Power Interface Testing

The first article RO unit shall be tested to verify the unit control system and high pressure pump soft start or drive meets the electric power interface requirements of MIL-STD-1399, Section 300A with Notice 1 dated 11 March 1992 for type I power systems.

4.6 Inspection of Painting Systems

All stages of painting shall be subject to full-time inspection by the procuring activity representative. Such inspection shall not relieve the manufacturer of his responsibility to provide quality materials and workmanship. Inspections shall ensure that painted surfaces are free of mechanical damage, blisters, cracks or flakes.